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LVTS, the Overnight Market, and Monetary Policy

by

Nadja Kamhi

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Nadja Kamhi

Department of Banking Operations
Bank of Canada
Ottawa, Ontario, Canada K1A 0G9
nkamhi@bankofcanada.ca

The views expressed in this paper are those of the author.
No responsibility for them should be attributed to the Bank of Canada.

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Abstract

Operational events in the Large Value Transfer System (LVTS) almost always result in a disturbance of the regular flow of payments. The author explores the link between payment flows and the overnight interest rate. She also explores the way that payments system frictions affect the overnight interest rate. Payments system frictions arise because LVTS participants lack full information on their own payment flows and those of others. This uncertainty diminishes as the final end-of-day settlement nears. By borrowing earlier in the day in the overnight market, however, participants can insure against being short at the final end-of-day settlement. The author first develops a general framework describing the role that payment flows and payments system frictions have on the overnight rate and then empirically tests the implications of this model. She finds that LVTS payment flows are an important determinant of pressure on the overnight interest rate.

JEL classification: E5
Bank classification: Payment, clearing, and settlement systems; Monetary policy implementation

Résumé

Les incidents d'ordre opérationnel qui surviennent au sein du Système de transfert de paiements de grande valeur (STPGV) perturbent presque toujours le flux régulier des paiements. L'auteure étudie le lien entre les flux de paiement et le taux du financement à un jour. Elle s'intéresse particulièrement à la façon dont les frictions du système de paiement influent sur ce taux. Les frictions naissent du fait que les participants au STPGV ne disposent pas d'une information complète sur leurs propres paiements ni ceux de leurs homologues. Cette incertitude diminue à mesure qu'approche le règlement final, à la fin de la journée. Les participants ont toutefois la possibilité d'emprunter plus tôt dans la journée, sur le marché à un jour, pour éviter d'être en défaut lors du règlement final. L'auteure établit un cadre général qui décrit l'incidence que les flux de paiement et les frictions du système de paiement ont sur le taux du financement à un jour, puis teste empiriquement les implications de son modèle. Elle constate que les flux de paiement du STPGV sont une source importante de pression sur le taux du financement à un jour.

Classification JEL : E5
Classification de la Banque : Systèmes de paiement, de compensation et de règlement; Mise en œuvre de la politique monétaire

1. Introduction

Operational events in a payments system almost always result in a disturbance of the regular flow of payments. This paper explores the extent to which changes in payment flows have the potential to affect the overnight interest rate.

The overnight interest rate is the interest rate at which funds are borrowed or lent for a term of one business day, the shortest term to maturity in the money market. The Bank of Canada sets the **target** overnight rate, which is its key monetary policy (MP) tool. The **actual** overnight rate is determined by the relative demand and supply conditions in the overnight (ON) market. A measure of the deviation of the actual ON rate from the target ON rate provides us with a corresponding measure of the efficiency of monetary policy implementation. The closer is the actual ON rate to the target, the more efficient is the monetary policy implementation.[1]

The first step in the transmission of MP takes place within the payments system, or more specifically, through the Large Value Transfer System (LVTS). Changes in the target ON rate immediately affect the lending and deposit rate charged to LVTS participants and then, through their overnight market participation, the actual ON rate. Efficient MP implementation necessitates a close integration between the LVTS and the overnight market; the link lies in the fact that LVTS participants' borrowing and lending activity in the overnight market is influenced by their LVTS payment flows. This paper explores the effect that payment flows and payments system frictions have on the efficiency of MP implementation. Payments system frictions arise because LVTS participants lack full information on their own payment flows and those of others. This uncertainty diminishes as the final end-of-day settlement nears. By borrowing earlier in the day in the overnight market, however, participants can insure against being short at final end-of-day settlement. This paper develops a general framework describing the role that payment flows and payments system frictions, in the form of information

[1] A measure of monetary policy efficiency, according to Blix, Daltung, and Heikensten (2003), is the closeness of inflation outcomes to the target. The measure of monetary policy *implementation* efficiency proposed in this paper is based on the same principle.

asymmetries, have on the ON rate. Empirical tests demonstrate that higher LVTS payment volume creates upward pressure on the ON rate. In the more recent period, a significant improvement is observed in the efficiency of MP implementation. Nevertheless, LVTS payment flows remain an important determinant of the pressure on the ON rate.

This study appears to be one of the first in-depth analyses of the ON rate as it relates to the LVTS and monetary policy implementation. Examples of some descriptive and informative work on the topic include Clinton (1997), Howard (1998), and Dingle (1998). The literature is sparse, partly because Canada has a unique monetary policy implementation mechanism. In most countries, financial market players are subjected to specified reserve requirements and monetary policy is implemented by controlling the supply of reserve funds. For example, Ho and Saunders (1985) and Hamilton (1996) provide models of the federal funds rate behaviour in the United States, which is closely related to the demand for reserve requirements of financial institutions. Furfine (2000) introduces interbank flows into the model as an additional determinant of the demand for federal funds. Moschitz (2004) finds that the volatility of the euro area overnight rate is closely related to the open market operations in a reserve maintenance period. Unfortunately, the results of these and related studies cannot be applied to Canada.

Section 2 provides a brief overview of the MP implementation mechanism in Canada. Section 3 introduces the general framework and the model. Section 4 describes LVTS payment flows and MP variables of interest. The implications of the model are empirically tested in section 5. Section 6 concludes.

2. Overview of the MP Implementation Mechanism

The LVTS is an electronic payments system that enables member financial institutions to send and receive payments that are immediately final (i.e., unconditional and irrevocable). Currently, there are 15 LVTS participants, including the Bank of Canada.

The Bank of Canada implements MP through the use of its standing facilities in the LVTS.[2] A change in the target ON rate immediately affects LVTS participants through both the interest rate paid on any surplus settlement balances held overnight at the Bank of Canada and the interest rate charged on any shortfall in participants' end-of-day settlement balances. LVTS participants' settlement balances will vary each day, depending on their payment flows and their liquidity management practices. The rate that the Bank of Canada pays participants on their surplus settlement balances is 25 basis points lower than the target ON rate, while shortfalls in end-of-day balances must be offset by taking a fully collateralized advance from the Bank of Canada at an interest rate that is 25 basis points above the target ON rate. The resulting 50 basis point spread between lending and deposit rates is known as the "operating band" and encourages participants to borrow from and lend to each other at rates that fall close to the midpoint of that range. They have the opportunity to do that half an hour before the end of the LVTS daily cycle, which is known as the pre-settlement period. During this time, participants search for trading partners and negotiate the terms of the loan, usually over the phone, lacking the information on the exact net positions of others. Lack of perfect information on the net positions of others creates market frictions and increases transactions costs associated with matching lenders and borrowers. However, the rates charged during the pre-settlement period do not enter the official ON rate calculations.

The actual ON rate is determined by the relative demand and supply conditions in the overnight market, where LVTS participants are active players. The market also includes a broad range of other financial market players such as banks, investment dealers, corporations, investment funds, trust companies, and government agencies. The trading mechanism in the overnight market is such that participants quote bid and ask prices for one-day loans, adjusting them slightly depending on whether they prefer to be lenders or borrowers. The brokers then post borrowing and lending rates and trades take place. Some trades are not arranged through brokers but directly between the overnight market participants. The Bank of Canada collects the information on ON rates and

[2] A more detailed description of the MP implementation mechanism can be found in Howard (1998). Woodford (2001) also provides a technical description of the monetary policy implementation mechanism used by Canada, Australia, and New Zealand, known as the channel system.

publishes it daily on its website. One of the measures includes all overnight loans and is obtained through direct communication with the overnight market participants. It is referred to as the actual ON rate. The other measure uses broker transactions data (a subset of all overnight loans) and is referred to as the Canadian overnight repo rate average (CORRA).

3. General Framework

The role of each of the LVTS participants is to send and receive payments, mostly on behalf of their clients but also on their own behalf.[3] Their objective is to fulfill this role, that is, execute all their payment transactions, at the lowest possible cost and subject to the LVTS rules of operation. The costs can be broken down into intraday and end-of-day costs. Intraday costs are associated with borrowing activity in the overnight market and in the pre-settlement period. End-of-day cost is the direct or opportunity cost incurred at settlement, and it is calculated as the difference between the lending or remuneration rate offered by the Bank of Canada and the overnight rate. The intraday demand for liquidity and the associated costs arise owing to the enforcement of bilateral and multilateral credit limits in the LVTS. Payments system frictions in the form of asymmetric information create pressure on the overnight rate owing to the fact that participants' projections of incoming payments and their timing are a lot less certain than their knowledge of outgoing payments. Thus, despite the fact that the overnight market consists of both borrowers and lenders, increased payment flows result in upward pressure on ON rates.

3.1 Intraday timing and information structure

Early morning: LVTS participants begin each day knowing the target LVTS cash setting for the day, which is posted on the Bank's website at the end of the preceding business day. The cash setting (CS) measures the amount of "excess" funds available in the LVTS. It is equal to the sum of the end-of-day (or pre-settlement period) net positions of the 14 participants, excluding the Bank of Canada. The ON rate from the previous business day is also posted on the Bank's website at 9 a.m. each day. In addition to this public information, LVTS participants have some (albeit limited) knowledge of the LVTS

[3] Anecdotal evidence suggests that close to 90 per cent of payments sent and received are on behalf of the clients.

transactions for the day. They can observe the backlog of client orders that accumulated overnight while the LVTS was closed. Each client order is a request by the client to make a payment on their behalf to another LVTS participant. Client orders (or outgoing payment requests) is private information and a source of payments system friction arising from information asymmetries. As a result, information on the expected incoming payments (other participants' client orders) and their timing is highly uncertain, especially on days when there are large payment flows.[4]

Late morning and afternoon: Participants will have sent all of their early morning payments. They will also fulfill any outgoing payments requests as well as receive some of the incoming payments sent to them. Based on the observed and forecast payment flows, they will decide how much to borrow/lend in the overnight market.

Late day (pre-settlement period) and closing: At the start of the pre-settlement period (6 p.m.), all incoming and outgoing client payments are completed and the net position is known with certainty. The pre-settlement period is then used to arrange overnight loans, for the purpose of achieving a desired end-of-day balance. At closing (6:30 p.m.), participants with negative balances must take an advance at a penalty interest rate that is 25 basis points above the target, and those with a positive balance are paid interest on their balance at a rate of 25 basis points below the target.

3.2 Participants' cash-management behaviour

In deciding how much to borrow earlier in the day in the overnight market versus late in the day, during the pre-settlement period, participants face a trade-off. Borrowing in the overnight market has the benefit of being less uncertain with respect to the ON interest rate charged (owing to the lack of a deep funds market late in the day[5]), but there is more uncertainty regarding the final end-of-day position and hence the amount of funds needed. On the other hand, borrowing late in the day, during the pre-settlement period, eliminates the end-of-day position uncertainty, since all incoming and outgoing payments

[4] Furfine (2000) measures the magnitude of the end-of-day balance uncertainty as a linear function of the volume of payments (incoming + outgoing) transacted on that day. He claims that the two are positively related because the probability of operational glitches, bookkeeping mistakes, or simply the failure of payments to arrive before the end of the day is positively related to the volume of payments transacted.

[5] The evidence in the Canadian case is mostly anecdotal, owing to the lack of transactions-level data.

have been realized, but interest rate uncertainty increases owing to the limited number of participants, imperfect information regarding their net balances, and higher transactions costs associated with matching lenders and borrowers.

Participants' expectations on the conditions for lending and borrowing during the pre-settlement period are also largely affected by the amount of the cash-setting target (known a day in advance). When the cash setting is low or 0, transactions costs may increase, since each participant will hold a relatively smaller positive position, which may be insufficient to cover the negative position of another participant. Since participants lack information on the net positions of others, search costs are higher. Alternatively, even if a single participant has exactly the offsetting surplus balance, it may not be able to lend all these funds, because the amount may exceed its internal credit exposure limit towards the other participant.

Accordingly, the demand for overnight funds, and hence the ON rate, will increase on the days when there are large (morning) payment flows. This will happen because each participant will increase their expected borrowing amount, and because the uncertainty increases with respect to the incoming payments. The ON rate will also increase when the cash setting is relatively low, because much of the demand for overnight funds will be shifted to the overnight market. Section 5 empirically tests this hypothesis.

4. Data

I use daily data spanning the period from February 1999, when the LVTS was introduced, to December 2004. There are a total of 1490 observations. The sample is split into two periods to reflect different approaches by the Bank of Canada in its cash-setting policy. The earlier period was one of introduction and adjustment as the Bank of Canada and the LVTS participants adapted to the new system. The current regime was formally implemented on 3 April 2001. Summaries of descriptive statistics for the variables of interest are provided in Tables 1 and 2.

Table 1: Daily Descriptive Statistics- Period I

04 Feb/99- 03 Apr/01 (N = 544)			
	Mean	Median	Std.Dev.
Cash Setting Target (millions $)	153.0	0	242.4
DEV_ON (basis points) = target ON rate – actual ON rate	-2.82	0	5.41
DEV_CORRA (basis points) = target ON rate – CORRA rate	-4.63	-2.28	6.84
Volume of payments sent	13,577	13,275	2,108
Correlation (DEV_ON, DEV_CORRA) = 0.95			

Table 2: Daily Descriptive Statistics- Period II

03Apr/01- 31Dec/04 (N = 940)			
	Mean	Median	Std.Dev.
Cash Setting Target (millions $)	98.5	50	132.4
DEV_ON (basis points) = target ON rate – actual ON rate	0.50	0.43	0.49
DEV_CORRA (basis points) = target ON rate – CORRA rate	-0.73	-0.6	1.23
Volume of payments sent	15,912	15,595	2,551
Correlation (DEV_ON , DEV_CORRA) = 0.14			

4.1 Cash setting

When the LVTS was first implemented on 4 February 1999, the cash setting was implicitly set at zero. However, it became apparent in subsequent months that the system was not working as intended, and so, starting in September 1999, the Bank began experimenting with non-zero (surplus) cash settings on certain days when higher payment volumes and uncertainties were expected to affect the ON market. These non-zero settings typically occurred at the beginning and end of each month. Consultations with LVTS participants also eventually led to experimentation with modest non-zero target cash settings on **all** business days, not just those expected to be unusually tight. Under the current regime, in place officially since April 2001, the minimum target cash setting is $50 million, with larger amounts of up to several hundred million around the beginning

and end of each month. The adoption of the current regime is assumed to have caused a break in the data. Consequently, I divide the sample into two periods. The large differences between the mean and standard deviations of the two periods are also indicative of a break in the series.

On some days, the actual cash setting will differ from the target cash setting.[6] In general, overshooting and undershooting the targeted cash-setting amount was much more frequent in the first period than in the second period. In the first period, the actual cash setting was below the targeted amount more often than above it. This pattern was reversed in the second period, as shown in Table 3.

Table 3: Actual vs. Target Cash Setting

	04 Feb /99- 03 Apr/01		03 Apr/01- 31 Dec/04	
	No. Days	% Days	No. Days	% Days
CS actual > CS target	21	*3.8*	38	*4.0*
CS actual < CS target	34	*6.2*	9	*0.95*

4.2 Measures of the overnight interest rate

The target ON rate is the Bank of Canada's key policy rate. Throughout the year, there are eight predetermined dates (fixed announcement days or FADs) when the Bank of Canada announces the level of the target ON interest rate. Each decision is announced by 9 a.m. on the day of the FAD via a press release. The target rate is also published on the Bank's website.

The ON money market financing rate is "the Bank of Canada estimate for the rate at which major dealers are able to arrange financing of securities inventory for a term of one business day."[7] The reported rate is based on data provided by primary dealers. Hereafter, I refer to the overnight money market financing rate as the (actual) ON rate. This rate is available daily on the Bank of Canada website at 9 a.m. for the previous business day. Another measure of the conditions in the overnight market is provided by

[6] Generally, the actual will be less than the target if there are uncovered Receiver General balances in the P.M. auction, and it will be greater than target on days when the Bank intervenes by injecting large amounts of liquidity in the market (via SPRAs).

[7] < http://www.bankofcanada.ca/en/rates/monmrt.htm >.

the Canadian overnight repo rate average (CORRA). This rate is based on the general collateral (consisting of Government of Canada T-bills and bonds) traded through and reported by Freedom International Brokerage Inc., Prebon Yamane (Canada) Ltd., and Shorcan Brokers Ltd.[8] It is also available on the Bank of Canada's website. Figure A1 in the appendix plots the deviations from the target rate for both measures of the overnight rate.

4.3 The behaviour of the ON rate(s)

Both the ON rate and CORRA are indicators of the overnight market conditions. When the overnight market conditions are "tight" (i.e., there is a greater than usual demand for liquidity), the ON rate as well as CORRA are expected to be higher. Likewise, at times of abundant liquidity, the ON rate and CORRA are expected to be lower. The magnitude and the sign of the deviations from the target are an indication of the degree and the direction of the pressure on the ON rate. If both rates are equally good at measuring these conditions, then the rates would be expected to be highly correlated. The full sample correlation between these series is nearly perfect, at 0.94. However, this observation is invalidated by calculating correlations separately in each period. In the period between February 1999 and April 2001 the correlation (0.95) is very close to that of the whole sample (0.94). However, since April 2001 the two rates are completely uncorrelated. The correlation coefficient drops from 0.95 to 0.14. The full sample correlation is dominated by the first subsample, even though it is the smaller of the two, because both series are more volatile in the first-period sample. The differences in the means and standard deviations of the two periods are quite substantial. In the period between February 1999 and April 2001, the ON rate was on average 2.8 basis points above the target. In the second period, the mean ON rate was 0.5 basis points below the target. CORRA has remained above the target ON rate in both periods, but the average deviation has dropped from 4.6 basis points to 0.73 basis points in the second period. CORRA is more volatile than the actual ON rate in both periods, possibly due to a smaller number of transactions (only those going through one of the three brokers) that are used in its calculation.

[8] Ibid.

The large deviations of both rates in the first period can partially be attributed to the uncertainty associated with the changes to the level of the target ON rate and more volatility in the level of the cash setting during this period. Additionally, prior to November 2000, interest rate changes were announced at irregular intervals. With the introduction of fixed announcement dates (FADs) in November 2000, the uncertainty associated with the timing of target ON rate changes has been greatly reduced.[9] This may have further contributed to the disparity in the behaviour of the ON rate and CORRA in period I versus period II.

4.4 Payment volumes

The average volume (number) of payments sent per day, excluding those sent by the Bank of Canada, has been growing every year since the first year of LVTS operation (see Tables 1 and 2). Within a given year, payment volumes increase from month to month. Generally, the average volume of payments tends to be the highest in December and the lowest in January. The monthly average volume has been increasing on a year-over-year basis as well.

4.5 SPRAs and SRAs

Special purchase and resale agreements (SPRAs) are repo-type transactions in which the Bank of Canada offers to purchase Government of Canada securities from primary dealers with an agreement to sell them back at a predetermined price the next business day. In this way, SPRAs enable the Bank to inject additional liquidity in the system when the ON rate exceeds the target by larger than what is considered an acceptable amount in order to reduce this deviation.

Sale and repurchase agreements (SRAs) are reverse repo-type transactions in which the Bank of Canada offers to sell Government of Canada securities to primary dealers with an agreement to buy them back at a predetermined price the next business day. The Bank thus removes excess liquidity from the system. SRAs are conducted on those days when the ON rate is trading sufficiently below the target ON rate.

[9] However, the Bank may still announce target overnight interest rate changes outside of the regular FADs, as was done in the days following the 11 September 2001 terrorist attacks.

The decision regarding whether to use SPRAs or SRAs is typically made each day at 11:45 a.m. based on the conditions in the overnight market as reported by major dealers through telephone conversations with Bank of Canada staff. Both SPRAs and SRAs are transacted at the target ON rate and therefore act as ON rate anchors.

SPRAs are more frequently used than SRAs in both periods (see Table 4). In the latter period, there is a large decrease in the frequency of SPRA use, but the mean and median value of the SPRA amount does not change significantly. SRAs are almost never used in the second period.

Table 4: SPRAs and SRAs

	04 Feb/99- 03 Apr/01 (N = 544)			04 Apr/01-31 Dec/04 (N = 940)		
	Volume	Value Mean/ Median (millions $)	% Days	Volume	Value Mean/ Median (millions $)	% Days
SPRAs	328	477/ 498	*60.0*	32	507/ 453	*3.4*
SRAs	42	554/ 475	*7.7*	2	433/ 433	*0.21*

5. Estimation and Results

5.1 Estimation

Based on the model described in section 3, the following equation is estimated:

$$DEV_ON_t = \beta_0 + \beta_1 DEV_ON_{t-1} + \beta_2 DEV_VOL_t + \beta_3 CSD_t + \beta_3 INT_t + \varepsilon_t$$

where

$ON_R_t^*$ is the ON rate target

ON_R_t is the actual ON rate (money market financing rate)

DEV_ON_t $= ON_R_t^* - ON_R_t$
measures the overnight interest rate deviation from the target, expressed in basis points. A negative value indicates that the ON rate is above the target rate and that the overnight market conditions are "tight." DEV_ON_t is positive when the ON rate is below the target rate.

VOL_t is the volume of payments sent during the day excluding those sent by the Bank of Canada. This is an approximation of the client orders. Although the majority of payments sent are customer payments, other types of transactions (interbank payments, foreign exchange swaps, etc.) are also included in the daily volume measure.

AVG_VOL_t is the one-month, or 22 business days, moving-average volume of sent payments.

DEV_VOL_t $= VOL_t - AVG_VOL_t$
is a measure of the volume of payments sent on day t relative to the past 22 days' average. DEV_VOL_t is negative on the days when payment flow volume is low and positive on particularly busy days of the month. DEV_VOL_t is our best approximation for the borrowing activity that would be observed in the overnight market.

CSD_t is the cash-setting dummy variable, which takes on the value of 1 whenever the cash setting is greater than the "average day" amount. Thus, in the period between 15 November and 5 December 2000, this amount is 200 million and for the rest of the sample the "average day" amount is considered to be 50 million. The cash-setting amount is set and announced a day in advance (and therefore is not affected by the actual payment flows for that day).

INT_t is the probability of intervention (through the use of SPRAs) by the Bank of Canada. See below for the methodology used to estimate this variable.

5.2 Bank of Canada intervention estimation

Since SRAs were used rather infrequently (see section 4), the focus is on the use of SPRAs as an intervention instrument. The SPRA dummy takes on a value of 1 on those days when SPRAs were conducted, and 0 otherwise. In order to avoid the endogeneity problems associated with directly including the SPRA dummy variable in the above equation, the probability of intervention is estimated using a probit estimation of the following form:

$$SPRA_t = \beta_0 + \beta_1 DEV_ON_{t-1} + \beta_2 DEV_VOL_t + \beta_3 ER_{t-1} + \varepsilon_t .$$

Here, *ER* denotes the Canada-U.S. bilateral exchange rate. All other variables are defined as before. *ER* serves as a proxy for market conditions and therefore affects the Bank of Canada's likelihood of market intervention. The coefficient estimates from the probit equation are used to estimate the probability of the Bank of Canada intervention, the *INT* variable. The coefficient values and the associated statistics are provided in Table 5.

Table 5: Maximum Likelihood Probit Estimation of Intervention with SPRAs

Variable	Coefficient	Std. Error	P-value
PERIOD I: 05Mar/99 – 03Apr/01			
C	14.47	3.21	0
ER_{t-1}	-9.77	2.15	0
DEV_VOL_t	9.76E-05	3.36E-05	3.6E-03
DEV_ON_{t-1}	-0.13	0.014	0
PERIOD II: 04Apr/01- 31Dec/04			
C	-3.97	1.28	0.002
ER_{t-1}	1.17	0.887	0.188
DEV_VOL_t	2.44E-04	3.75E-05	0
DEV_ON_{t-1}	0.3	0.198	0.131

Predictability Power (cutoff probability =0.5)

	SPRA = 0	SPRA = 1
PERIOD I: 05Mar/99 – 03Apr/01		
% Correct	72.27	73.6
% Incorrect	27.73	26.4
PERIOD II: 04Apr/01- 31Dec/04		
% Correct	100	0
% Incorrect	0	100

5.3 Structural break

The change in the cash-setting regime documented in the previous section occurred on 3 April 2001. I conduct a structural breakpoint test of an unknown breakpoint date that falls within a specific interval, as in Andrews (1993). This procedure involves conducting a Chow breakpoint test for every date within a specified interval and choosing the one with the highest F-statistic value. I define this interval to be between 2 November 1999 and 31 May 2001 because of a significant change in the volatility and the mean of the ON

rate deviations during this period. The F-statistic is plotted in Figure A2 in the appendix. The peak value (F-statistic = 73) is found to be on 12 and 15 November 1999, which corresponds with an announcement of a cash-setting target of 200 million dollars on an "average day" and its subsequent implementation on 15 November.[10]

5.4 Results

Dickey-Fuller unit-root tests indicate that there are no unit roots in any of the series. The regressions are estimated by ordinary least squares (OLS) using Newey-West heteroscedasticity and autocorrelation (HAC) standard error and covariance corrections. The subsequent analysis and estimation are done using the two identified structural breakpoint dates, 15 November 1999 and 3 April 2001, producing three separate regressions. The original Period I is now broken into two subperiods. Estimation using intervention probability is not done for the 4 April 2001–31 December 2004 period, because of its poor predictability power and the very infrequent interventions during this time (see Table 5). Regression results are shown in Table 6.

Table 6: Regression Results

Dependent variable: DEV_ON_t	05Mar/99-10Nov/99	15Nov/99-03Apr/01	04Apr/01-31Dec/04
C	1.72 (2.53)	3.45E-01* (1.96E-01)	3.26E-01*** (4.49E-02)
DEV_VOL_t	-1.10E-03*** (2.67E-04)	-1.25E-04** (6.04E-05)	-1.92E-05** (9.71E-06)
DEV_ON_{t-1}	6.10E-01*** (9.52E-02)	5.79E-01*** (5.71E-02)	3.62E-01*** (8.09E-02)
CSD_t	4.02*** (1.37)	-9.84E-02 (1.94E-01)	-5.91E-02 (6.51E-02)
INT_t	-6.46** (3.28)	-7.42E-01 (5.20E-01)	N/A
R^2 adjusted	0.56	0.53	0.14
S.E. Regression	3.75	1.23	0.46

Standard errors are shown in parentheses.
*= significant at 10%, **= significant at 5%, ***= significant at 1%

[10] See Merrett (1999).

In all three regressions, the payment flow coefficient has the correct sign and is statistically significant. This result agrees with the theoretical model, which suggests that higher payment flow creates upward pressure on the ON rate because of LVTS participants' increased demand for overnight funds. For example, in the earliest period, an increase of 1,000 payments above the 22-day moving-average volume increases the ON rate by 1 basis point. The coefficient gradually diminishes in magnitude, as do the overnight rate deviations, but it remains statistically significant. Thus, the impact of an increase or decrease in the payment flows remains an important factor in determining the pressure on the overnight rate. In the most recent period, an increase of 1,000 payments above the 22-day moving-average volume increases the ON rate by a negligible 0.0192 basis points.

The cash-setting dummy is significant in the first regression. During this period, whenever there was an increase in the cash setting above the "average amount," the overnight rate dropped below the target rate (by about 4 percentage points). Increasing the cash-setting amount relieved some of the upward pressure on the ON rate as predicted by the hypothesis. In the subsequent periods, the participants observed that the cash setting would be adjusted according to the market conditions, so its effect on the overnight rate disappeared (i.e., the coefficient is not significant) and the overnight rate deviations became smaller. These results illustrate the improvements in the efficiency of MP implementation under a changed cash-setting regime. Similarly, the INT coefficient is insignificant in the second period regression, since SPRAs became more effective in bringing the overnight rate closer to the target.

Results obtained using CORRA as an overnight rate measure confirm that the payment flow coefficient decreases in magnitude over time but remains statistically significant even in the latest period. These estimates can be found in the appendix, Table A1.

6. Conclusion

One of the main roles and responsibilities of the Bank of Canada is that of conducting and implementing monetary policy. The key monetary policy rate is the overnight interest rate (ON). The efficiency of monetary policy implementation can be assessed by measuring how well the ON rate tracks the target ON rate. In this paper, I assess the effect that changes in the daily LVTS payment flows have on the behaviour of the ON rate relative to the target ON rate.

There has been a large difference in the behaviour of the ON rate relative to its target (and therefore of the efficiency of monetary policy implementation) over time. In particular, the period between February 1999 and April 2001 can be characterized as one of learning and adjustment, for both the Bank of Canada and the LVTS participants. The target cash settings, initially always zero, were subsequently subject to large and frequent changes. This period was characterized by less precision in attaining the targeted cash settings, frequent interventions in the overnight market by the Bank of Canada, and large and volatile ON rate deviations. Since April 2001, there has been a substantial improvement in attaining the targeted cash setting along with a more established pattern of cash-setting amounts, a much better record of achieving the target ON rate, as well as fewer Bank of Canada interventions in the overnight market. Nonetheless, I find that LVTS payment flows are always an important determinant of the pressure on the overnight interest rate. That is, an increase in the payment volume creates upward pressure on the ON rate. I therefore conclude that payments system frictions have the potential to impede the efficiency of monetary policy implementation but that the effective use of cash setting policy can be used to mitigate this effect.

Further research will focus on participant's early morning net positions and/or the volume and value of sent payments in relation to the ON rate pressures. This will provide further insights into the differences in participants' payment activity and their impact on the system.

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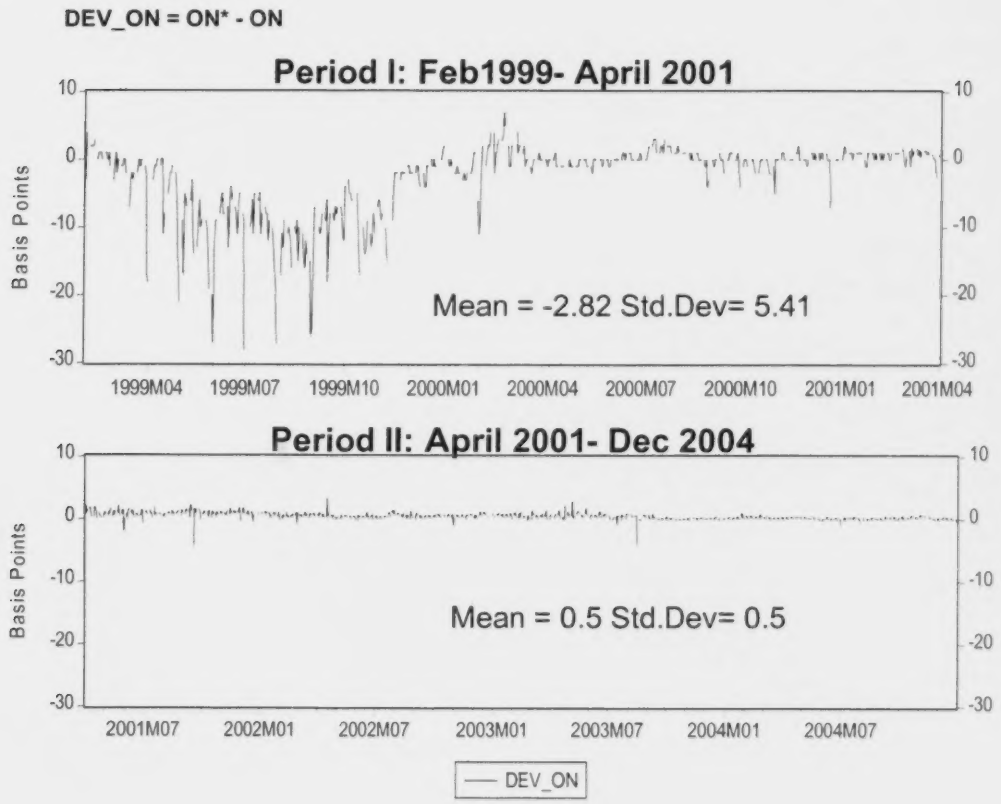
Appendix

Figure A1: Overnight rate deviations from the target



(continued)

Figure A1 (concluded)

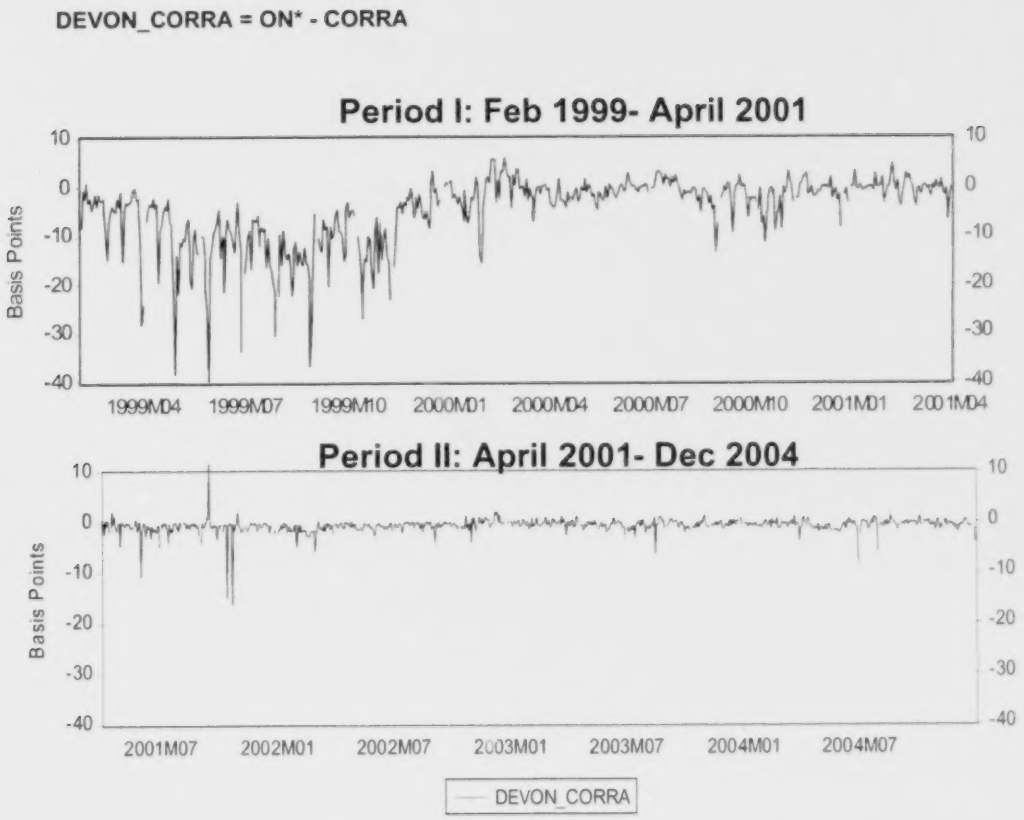


Figure A2: Structural breakpoint test F-statistic

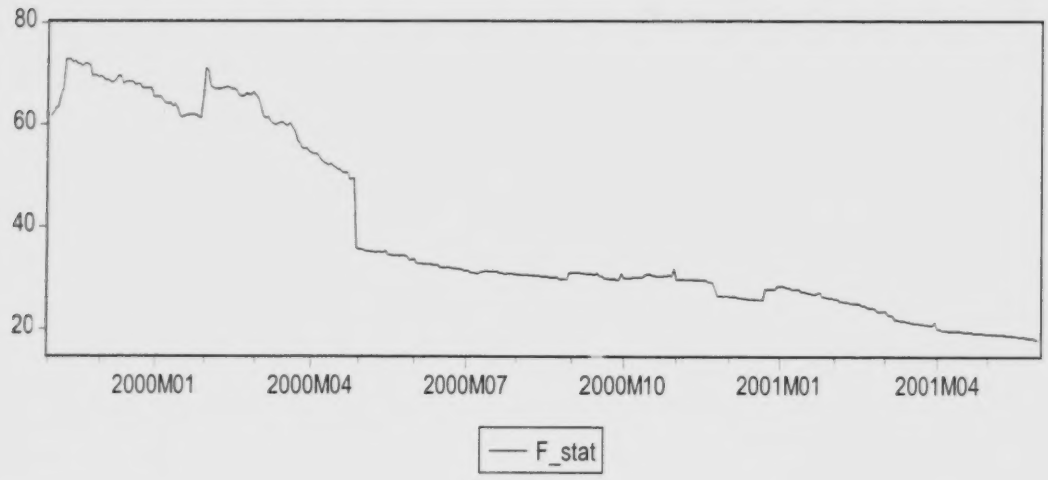


Table A1: Regression Results (using CORRA measure of ON rates)

Dependent variable: DEV_ON_t (CORRA)	05Mar/99-10Nov/99	15Nov/99-03Apr/01	04Apr/01-31Dec/04
C	1.77 (3.25)	1.59E-01 (2.68E-01)	-5.22E-01*** (6.20E-02)
DEV_VOL_t	-1.78E-03*** (3.28E-04)	-2.84E-04*** (1.08E-04)	-7.83E-05** (3.43E-05)
DEV_ON_{t-1} (CORRA)	4.65E-01*** (9.54E-02)	4.93E-01*** (4.48E-02)	1.72E-01*** (6.58E-02)
CSD_t	6.74*** (2.02)	1.98E-02 (3.20E-01)	-4.33E-01** (2.07E-01)
INT_t	-9.89** (4.16)	-1.74*** (6.80E-01)	N/A
R^2 adjusted	0.47	0.43	0.082
S.E. Regression	5.34	2.23	1.19

Standard errors are shown in parentheses.
*= significant at 10%, **= significant at 5%, ***= significant at 1%

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